

5

TEMPERATURE COMPENSATION VALVE

TECHNICAL FIELD

10

The present invention relates generally to flow valves and, more specifically, to a mechanically operative gaseous flow valve that serves to compensate for pressure variations caused by fluctuations in temperature.

15

BACKGROUND OF THE INVENTION

20

Flow valves that serve to regulate the flow of fluids in environments that are subjected to extreme temperature fluctuations are known. Generally, a change in temperature to the environment of the container holding the fluid causes a change in temperature of the fluid contained within. Additionally, this change in temperature causes either an increase, or a decrease in pressure. Generally, an increase in temperature causes an increase in pressure, and a decrease in temperature causes a decrease in pressure. When you apply these changes in pressure to an actuator the performance of the actuator also

changes. Inside a typical actuator resides a piston wherein applying a high pressure flow on that piston will instigate a greater force. The greater force causes the actuator to move with greater velocity. Conversely, if temperature is low, then pressure is low. The low pressure causes a decrease in force exerted on the piston. This decrease in force causes the piston to move slower. It is desirable to control flow of gas into the actuator so that when temperature and pressure are low, the orifice that regulates the flow of the fluid is larger, thereby allowing gas to flow quickly into the actuator. Conversely, when the temperature and pressure are high the aforementioned orifice of the valve should be smaller, so that the gas flow into the actuator is restricted.

In view of the above, it is essential for many applications to keep the flow rate of fluid constant while temperature fluctuates between hot and cold extremes. One such application, requiring a constant flow rate during temperature fluctuations, is in the field of aeronautics.

Devices that provide a stable fluid flow are known. One such device is the Fluid Dispenser With Stabilized Fluid Flow described in U.S. Patent Number 6,413,238. The device provides a fluid dispenser and method of operation. The device includes a feedback system which allows the device to respond in a timely and measured manner to changes in the dispensing flow rate of fluid from the device. The device has a fluid reservoir and an outlet which optionally may have a flow or pressure resistance unit incorporated, into the outlet, and an electric gas generation module or reversible pump which provides gas pressure to dispense the fluid from the reservoir. The device also has a sensor for detecting

and measuring internal or external operating parameter indicative of flow rate of the fluid being dispensed. Feedback from the sensor is used by a controller to control electric current to the gas generation module, with the current being adjusted by the controller to adjust the amount of gas produced in a manner
5 which will prevent the flow rate of the dispensed fluid from exceeding desired maximum or minimum limits.

While the aforementioned device regulates the flow of a fluid and adjusts for changes in pressure, the device is extremely complex and requires many electronic components including sensors and detection units. Additionally, such a
10 device is expensive to manufacture.

An additional device for regulating a fluid is disclosed in the Blue Flame Gas Smooth Top Range of U.S. Pat. No. 3,870,457. The thermal fuel valve is used with an electric igniter in a gas range appliance to control gas flow while the igniter provides automatic gas ignition at a burner. The electric igniter is
15 positioned next to the burner and an internal electric heater in the thermal fuel valve enclosure is positioned to heat a thermally responsive heat warpable actuator that moves the poppet to open the valve when the devices are connected for series electric energization. The thermal fuel valve will open and allow gas to flow to the burner only when the electric igniter has been energized.
20 Furthermore, the valve is calibrated to open only when the igniter is near or at a temperature suitable for igniting the gaseous fuel. Since the force required to be exerted by the actuator to move the poppet from its seat is dependent on the gas

pressure in the valve, such calibration normally would take into consideration the normal gas pressure.

While the aforementioned device either opens or closes depending on temperature, it does not serve to regulate the flow rate of fluid constant while temperature fluctuates between hot and cold extremes. The device merely allows for gas to flow provided the temperature is at an appropriate level.

What is needed in the art is a gas valve that maintains a defined flow rate across a temperature range even though the upstream pressure fluctuates with temperature.

Furthermore, what is needed in the art is a gas valve that maintains a defined flow rate across a temperature range even though the upstream pressure fluctuates with temperature, wherein the gas valve is substantially mechanical and does not require additional temperature monitoring or controlling devices.

SUMMARY OF THE INVENTION

The present invention provides a gas valve that maintains a substantially constant, or defined flow rate across a temperature range even though the upstream pressure fluctuates with temperature.

Furthermore, the present invention provides a gas valve that maintains a substantially constant or defined flow rate regardless of fluctuations in temperature or pressure that is substantially mechanical and does not require additional temperature monitoring or controlling devices.

A temperature compensation valve is hereby provided wherein the inner cavity of the valve comprises a puck, a metal piston (gas control device), and a spring. The puck is preferably comprised of a non-metallic material having a coefficient of expansion than the piston. The spring serves to bias the piston
5 towards the puck, and the puck expands and contracts proportionately in response to fluctuations in temperature of the upstream gas. The system can be under tuned or over tuned to obtain a desired flow rate verses temperature. Additionally, the piston may further comprise a pair of o-rings on opposite sides of the orifice.

10 A particular embodiment of the gas valve may further comprise a fine tune adjustor for moving the piston to the appropriate bias position at room temperature. Furthermore, a position measurement rod may be included to assure proper operation of the valve and provide the operator with a visual indication of the position of the piston.

BRIEF DESCRIPTION OF THE DRAWINGS

The above-mentioned and other features and advantages of this invention, and the manner of attaining them, will become appreciated and be
20 more readily understood by reference to the following detailed description of one embodiment of the invention in conjunction with the accompanying drawings, wherein:

FIG. 1 is a longitudinal cross sectional view of the temperature compensation valve of the present invention; and

FIG. 2 is a pneumatic control system having the temperature compensation valve of the present invention.

5

DETAILED DESCRIPTION OF THE DRAWINGS

10 Referring now to the drawings, and particularly to **Fig.1**, there is shown an embodiment of the temperature compensation valve **10** of the present invention. The temperature compensation valve **10** comprises in one form thereof an inner cavity further comprising a puck **13**, a piston or gas control device **15**, and spring **14**. While the preferred embodiment specifies a fluorosilicone elastomeric rubber puck, any suitably sized device that expands and contracts when exposed to
15 fluctuations in temperature may be used. Additionally, while the piston **15** in the illustrated embodiment is metal, any suitable material may be used.

Referring again to **Fig. 1**, the spring **14** serves to bias the piston **15** toward the puck **13**. Furthermore, the puck **13** expands and contracts proportionately in
20 response to increases and decreases in temperature of the upstream gas. The piston **15** will move accordingly, wherein an increase in temperature causes the puck **13** to expand, thereby directing the piston **15** to obstruct the orifice **17**, through which gas flows from the inlet **11** to the outlet **12**.

In operation, a gas enters the valve **10** through the inlet **11** and exits the
25 valve **10** through the outlet **12**. A pressure balanced metal piston **15** is positioned

between the inlet **11** and the outlet **12** to modulate flow rate as a function of temperature. As temperature increases, the puck **13** expands, thereby urging the piston **15** toward the spring **14**. In addition to compressing the spring, the expansion of the puck **13** also causes the piston to cross the threshold of the orifice **17**, thereby obstructing flow through the orifice **17**. As the piston **15** is further forced in opposition to the spring **14**, the piston **15** covers a greater portion of the orifice **17**, thereby effectively regulating the flow through the orifice **17**.

The piston **15** further comprises a pair of o-rings **18a** and **18b**. The o-rings **18a** and **18b** are seated within a pair of annular groves **24a** and **24b** in the outer wall **23** of the piston **15**, and communicate with the inner wall of the inner cavity (not shown) of the temperature compensation valve **10**. Additionally, the piston **15** further comprises a first end **20** and a second end **21**, wherein said second end **21** has a flange **22** suitable for retaining the biasing spring **14**.

As temperature surrounding the valve decreases the puck **13** contracts. At this point, the spring **14** urges the piston **15** toward the puck **13**, thereby effectively increasing the orifice area **17** and allowing for increased gas flow. The net result is a substantially constant or predetermined gas pressure downstream of the orifice despite variation in upstream pressure caused by fluctuations in temperature.

A particular embodiment of the present invention further comprises a fine tuning adjuster **16**. The fine tuning adjuster **16** provides the operator a means for moving the piston **15** to appropriate bias position at room temperature, thereby

allowing operator to compensate for various expansion rates and qualities of the puck **13**. The fine tuning adjuster **16** comprises in one form thereof a threaded nut **25** and a threaded fitting **26**, wherein advancing the threaded nut **25** into the threaded fitting **26** urges the puck **13** toward the piston **15**, causing the piston to increasingly obstruct the orifice **17**. Conversely, turning the threaded nut **25** in the opposite direction effectively allows the biasing spring **14** to urge the piston **15** away from the orifice **17**, thereby increasing the size of the orifice **17** opening.

Furthermore, a particular embodiment of the present invention may include a position measurement rod **19**. Generally, the position measurement rod **19** will protrude outward from the valve **10**, and provides the operator with a visual indication of the current position of the piston **15** within the valve **10**. The position measurement rod **19** comprises a center rod **27** and an end knob **28**. The center rod **27** is in communication with the flanged end **21** of the piston **15** and is substantially surrounded by the biasing spring **14**. As the piston **15** advances toward the biasing spring **14**, the flanged end **21** of the piston **15** also advances the center rod **27** and an end knob **28** from the valve housing. Conversely, as the biasing spring urges the piston away from the orifice, the center rod **27** and an end knob **28** retreat into the valve housing, thereby providing a visual indication of the position of the piston **15**. The position indication rod **19** and fine tuning adjuster **16** allow for calibration and maintenance of the temperature compensation valve **10**.

Referring to **Fig. 2**, a pneumatic control system **30** having the temperature compensation valve **10** as disclosed above is shown. The pneumatic control

system **30** includes a gas source **31** for delivering gas to the inlet **11** of the temperature compensation valve **10**. The outlet **12** of the temperature compensation valve **10** is in fluid communication an actuator **32**.

Additionally an embodiment of the present invention is contemplated
5 wherein the length of the biasing spring **14** may be aptly selected to counter the expansion of a puck **13** thereby causing the position of the diaphragm or piston **15** to remain substantially unchanged over a range of temperatures. In a classical helical spring controlled regulator the sensing spring load determines the regulator output pressure. The output pressure acts on one side of a
10 diaphragm or piston **15** while the spring acts **14** on the other side. At the point where a force balance occurs the spring load is equal to the pressure multiplied by the diaphragm area. Hence there is a direct relationship between the spring force and the regulator pressure.

As regulator temperature decreases, the modulus of rigidity of the spring
15 material **14** increases and hence the spring force, for the same spring deflection, becomes greater causing the regulator output pressure to increase. By placing a material (a rubber puck **13** for example) in series with the spring **14** this increase in force can be countered. The coefficient of expansion of the material causes the puck **13** to contract at colder temperatures and due to the differing coefficient
20 of expansion between the body of the regulator and the material **13** the length of the spring **14** increases. This reduces the spring **14** deflection and hence reduces the force it applies to the diaphragm **15**. If the change in spring **14** length is chosen correctly it can exactly oppose the increase in force due to the modulus

change. As temperature increases the process is reversed, wherein the spring **14** modulus decreases and the puck **13** length increases thereby assuring that the spring force remains unchanged.

5 The embodiments described are chosen to provide an illustration of principles of the invention and its practical application to enable thereby one of ordinary skill in the art to utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. Therefore, the foregoing description is to be considered exemplary, rather than limiting, and the true scope of the invention is that described in the following claims.

10

15

20